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(73) Proprietor: NISSEI JUSHI KOGYO KABUSHIKI KAISHA
2110, Ooaza Minamijo Sakaki-machi
Hanishina-gun Nagano-ken (JP)

(72) Inventor: Takada, Minoru Nissei Jushi Kogyo Kabushiki Kaisha
2110, Ooaza Minamijo Sakaki-machi
Hanishina-gun Nagano-ken (JP)

(74) Representative: Stuart, Ian Alexander et al
MEWBURN ELLIS & CO. 2/3 Cursitor Street
London EC4A 1BQ (GB)

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Description

This invention relates to a mold clamping device, and particularly, to a mold clamping device for injection molding machines and die casting machines.

In the direct pressure type mold clamping devices for injection molding machines and die casting machines, it is necessary to open or close molds at a high speed or reduce the time of the molding cycle. It is also necessary to clamp molds with great force to oppose the molding pressure. To meet these requirements, such mold clamping devices have generally complex structures. Many different types of these devices exist.

For example, a booster-ram type mold clamping device is shown in Fig. 12. In this device, a smaller-diameter booster ram 11 slidably fits into a larger-diameter clamping ram 10. Oil is introduced into the smaller-diameter cylinder chamber 13 of the clamping ram 10 via an oil path 12 provided in the booster ram 11 for high-speed mold closure. Oil is also introduced into a rear chamber 14 of the clamping ram 10 at a negative pressure from an oil tank 16 via a prefill valve 15. After mold closure, high-pressure mold clamping is conducted by closing the prefill valve 15 and introducing oil into the rear chamber 14 of the clamping ram 10.

However, in the above booster ram type mold clamping device, the rear chamber 14 of the clamping ram 10 is at a negative pressure during high-speed advancing of the clamping ram 10. suction force introduces oil to the rear chamber 14 from the oil tank 16 so that there arise the following problems :

(1) The oil tank 16 requires a capacity larger than a mold clamping cylinder to prevent air suction, so that the mold clamping devices have to be large.

(2) Upon introducing oil into the rear chamber 14 of the clamping cylinder from the oil tank 16 by suction, high-speed advancing movement will be unstable. The oil path provided between the oil tank 16 and the rear chamber 14 of the clamping cylinder and the prefill valve 15 has to be large in diameter to reduce fluid resistance.

(3) On switching to tight clamping, shock often occurs because the oil pressure in the rear chamber 14 is changed from negative to high pressure quickly, and the time of the molding cycle is longer because rising pressure requires more time.

A mold clamping device is disclosed in Japanese Provisional Publication 53-42248 which comprising, a clamping piston which is slidably fitted in a clamping cylinder, a clamping ram of the same diameter and a high-speed advancing cylinder provided on the front and rear faces of the clamping piston, an oil path, which can be opened or closed, connecting the front and rear chambers of the clamping cylinder, and a small-diameter booster ram which is slidably fitted into the high-speed advancing cylinder.

In this clamping device, in operating the clamping ram at a high speed by introducing oil into the high-speed advancing cylinder from the booster ram, there are no problems as stated above because the oil travels from the front chamber to the rear chamber without negative pressure in the rear chamber by connecting chambers provided on the front and rear sides of the clamping piston. However, with the structure of this device, the total length of the device should be more than twice as long as its clamping stroke so that the device is large, heavy, and expensive.

A mold clamping device for injection molding machines disclosed in Japanese Provisional Publication 57-115329 (nearest prior art document) has the following construction. Namely, a plurality of liquid-pressure driven cylinders for opening molds are provided in parallel to a tight clamping cylinder. A piston is slidably fitted in the clamping ram of the clamping cylinder from the back. The liquid-pressure chamber of the liquid-pressure cylinder is connected to the front chamber of the clamping cylinder. The front chamber of the clamping cylinder is connected to the rear chamber thereof via an oil path provided in the piston section of the clamping ram. An open-close valve for opening or closing the oil path is operated by oil pressure independently.

In this device, for opening or closing molds, the oil in the front or rear chambers of the clamping cylinder and the oil in the liquid-pressure chamber of the liquid-pressure driven cylinder are moved via the oil path provided in the piston section of the clamping ram so that almost no negative pressure is generated in any sections in the cylinder and smooth movement occurs. Additionally, the clamping cylinder and the liquid-pressure driven cylinder are provided in parallel so that the total length of the device can be reduced.

There are also the following problems in the device :

(1) Because the mold opening operation is driven by the liquid-pressure driven cylinder, a plurality of the liquid-pressure driven cylinders must be provided on both sides of the clamping cylinder for balancing mold opening action as stated above.

(2) When the molds are opened, the oil chamber of the liquid-pressure driven cylinder is pressurized so that the chamber is connected to the front and rear chambers of the clamping cylinder for oil flow. Therefore, the oil pressure affects not only the chamber of the liquid-pressure driven cylinder but the front and rear chambers of the clamping cylinder so that the liquid-pressure driven cylinder must have a pressure proof structure. The front chamber of the clamping cylinder, which is not used for driving to open molds or to clamp tightly, also must have a pressure proof structure. With a pressure-proof structure, the device must be larger and heavier.

(3) The valve which opens or closes the oil path, provided in the piston section of the clamping ram, is controlled in its operation by the oil path provided in the clamping ram and extended in the axial direction thereof and by the oil circuit connected to the path whose one end is opened to the surface of the clamping ram located in the vicinity of a movable board and is connected to a hydraulic machine via external piping. However, with this structure, it is difficult to machine or assemble the clamping ram, and there are problems in durability and safety because of the connecting of the external piping to the movable clamping ram.

Preferred embodiments of the present invention enable one to solve the above stated problems, by providing a mold clamping device having high performance, whose total length is half that of conventional booster-rams, which has a simple structure, and which can be compacted, has a light weight, and can be marketted at low cost.

In this invention, the mold clamping device has a clamping cylinder which slidably fits a clamping ram whose front end is connected to a movable board of an injection molding machine. A support cylinder is provided in parallel to the clamping cylinder. A support piston is slidably fitted in the support cylinder, and the front end of the rod of the piston can be connected to the movable board of the injection molding machine.

A piston section of the clamping ram divides the clamping cylinder into a chamber and a rear chamber. These chambers and a chamber of the support cylinder are connected by an oil path to one another. There is provided means in the oil path which opens or closes the oil path between the rear chamber and the front chamber and the chamber of the support cylinder.

In this invention, the effective pressure receiving area of the rear chamber is designed to substantially equal the value which represents the sum of the effective pressure receiving area of the front chamber and the effective pressure receiving area of the chamber of the support cylinder.

According to this invention, when the movable board and the support piston move together during high-speed mold closure, the rear chamber will not be at a negative pressure because the oil quantity supplied to the rear chamber from the the front chamber and the chamber of the support cylinder is equal to the required oil quantity of the rear chamber.

The high-pressure clamping is executed by the oil supplied to the rear chamber after closing the oil path to the rear chamber by the means for opening or closing. The opening and closing of the oil path can be performed by a switching valve.

The front and rear chambers can be connected by a connecting-through-hole provided in the piston section of the clamping ram, and an open-close valve can be provided in the oil path. This open-close valve is formed as a ring piston which is movably fitted on the rear end of the clamping ram, and the one end face of the ring piston opens or closes the oil path. The operation of this open-close valve is controlled by the oil flow from the front chamber to the rear chamber when the molds close. When the molds open, it is preferable that the oil in an opening chamber is supplied to a chamber which is formed by the inner face of the open-close valve and the outer face of the clamping ram.

An embodiment of the invention may offer many advantages. In a high-speed mold closure operation, the rear chamber of the clamping cylinder will not be at a negative pressure so that quick pressurizing can be executed. The total length of the device can be half that of a conventional one so that the device can be reduced in size, weight, and costs. Furthermore, a complex valve such as a prefill valve is not necessary so that it will be easy to design and manufacture, and reliability and utility are increased.

The support cylinder is not used for pressurizing, and it affects the operation of the movable board insignificantly so the movement of the movable board can be balanced without provision of a plurality of support cylinders.

Mold closure or opening can be executed by the pressurizing of the chambers of the clamping ram only so there is generated little pressure in the front chamber and chamber of the support cylinder throughout the cycle. A high degree of hardness is not required for the front lid of the clamping cylinder, the support cylinder, and the support piston, so that they can be simple and compact in structure.

The chamber formed by the inner face of the open-close valve and the outer face of the clamping ram may be pressurized by the oil from a chamber of the clamping ram via a through-hole bored in the clamping ram to drive the open-close valve, and thus external piping is not necessary. Therefore, the present device will be easy to manufacture and assemble, and has a high durability and safety.

Some embodiments of the invention will now be described with reference to the accompanying drawings, which are provided for illustration only and do not limit the invention, and wherein :

Fig. 1 shows a cross sectional view of the mold opening state of a device according to a first embodiment of the present invention ;

Fig. 2 shows a cross sectional view of the high-speed mold closing state according to a first embodiment of the present invention ;

Fig. 3 shows a cross sectional view of the tight clamping state according to a first embodiment of the present invention ;

Fig. 4 shows a cross sectional view of the mold opening state of a device according to a second embodiment of the present invention ;

Fig. 5 shows a cross sectional view of the high-

speed mold closing state according to a second embodiment of the present invention ;

Fig. 6 shows a cross sectional view of the tight clamping state according to a second embodiment of the present invention ;

Fig. 7 shows a cross sectional view of the tight clamping state of a third embodiment according to the present invention ;

Fig. 8 shows a cross sectional view of the mold opening state of a fourth embodiment according to the present invention ;

Fig. 9 shows a partial cross sectional view of the state of pressurizing chamber C according to a fifth embodiment of the present invention ;

Fig. 10 shows a partial cross sectional view of the state of pressurizing chamber D according to a fifth embodiment of the present invention ;

Fig. 11 shows a cross sectional view of the state of mold opening of a sixth embodiment of the present invention ; and

Fig. 12 shows a cross sectional view of a conventional booster ram type mold clamping device.

The preferred embodiments of the invention will be described in detail with reference to accompanying drawings, but the invention is not to be construed as being limited to these particular embodiments.

It should be noted that like parts are designated by like reference numerals.

Embodiment 1

In Figs. 1 to 3, a movable board 20 is guided to move to and away from a fixed board 21 by a tie bar 23 which is bridged between the fixed board 21 and a cylinder block 22. On opposite faces of the movable board 20 and the fixed board 21, there are provided a movable mold 24 and a fixed mold 25. On a base 26 provided at the rear side of the fixed board 21, there is provided an injection machine 27 which can be moved to and away from the fixed mold 25. There are provided a clamping cylinder 28 and a support cylinder 29 which are arranged in parallel in the cylinder block 22. A clamping ram 30 whose front end is connected to the rear face of the movable board 20 is slidably fitted in the clamping cylinder 28 through the front lid 9. The inner space of the clamping cylinder 28 is divided into a front chamber A (described later) and a rear chamber B (described later) by the piston section of the clamping ram 30.

A high-speed piston 31 whose rear end is fixed on the inner rear wall of the clamping cylinder 28 is slidably fitted in the clamping ram 30. The inner space of the clamping ram 30 is divided into a chamber C and a chamber D by the large-diameter piston section which is provided at the front end of the high-speed piston 31.

The chambers C and D are respectively connected to a hydraulic machine (not shown) provided outside of the cylinder block 22 via oil paths 32 and 33 bored in the high-speed piston 31.

As shown in Fig. 1, the total length of the device including the clamping cylinder 28 is decreased because the large-diameter piston section of the clamping ram 30 is provided at the rear end thereof and the large-diameter piston section of the high-speed piston 31 is provided at the front end thereof.

A support piston 34 is slidably fitted in the support cylinder 29. The piston rod 46 of the support piston 34 is connected to the rear face of the movable board 20 through a lid 8. Therefore, the support piston 34 slides in the inner space of the support cylinder 29, and at that time the support piston 34 and the movable board 20 move together. There is formed a chamber E by the support piston 34 in the inner space of the support cylinder 29. The rear chamber of the support cylinder 29 is opened to the atmosphere.

There is provided an oil path 36 in a wall 35 between the clamping cylinder 28 and the support cylinder 29. The oil path 36 connects the chambers A and B of the clamping cylinder 28 and the chamber E of the support cyliner 29 to one another. In the vicinity of the oil path 36 there is formed a high-pressure switching cylinder 37. The oil path 36 is opened or closed by a high-pressure switching piston 38 which is slidably fitted in the high-pressure switching cylinder 37.

Chambers F and G are formed by the high-pressure switching piston 38 in the high-pressure switching cylinder 37.

Elements 39 and 40 are an oil port to the chambers F and G. Element 41 is an oil port to the chamber B.

The chamber A or E is connected to an oil tank 45 via a spring-check valve 43 and a check valve 44 which are provided in parallel and facing opposite directions.

One feature of the invention is that the sum of the effective pressure receiving area of the chamber A of the clamping cylinder 28 (the area of the piston section of the clamping ram 30 minus the area of the rod section thereof) and the effective pressure receiving area of the chamber E of the support cylinder 29 (the area of the piston section of the support piston 34 minus the area of the rod section thereof) is formed substantially equal to the effective pressure receiving area of the chamber B of the clamping cylinder 29 (the area of the piston section of the clamping ram 30 minus the area of the small-diameter section of the high-speed piston 31).

The action of the device is described below.

The high-speed mold closure :

In a mold opening state as shown in Fig. 1, the high-speed mold closure is executed by supplying the oil to the chamber C, and then the oil in the chamber D is returned to the oil tank 45. The oil in the chambers

A and E which is compressed by the advancing movable board 20 travels to the chamber B via the oil path 36. In this case, the pressure in the chamber B will not be negative because the sum of the effective pressure receiving area of the chambers A and E is substantially equal to the effective pressure receiving area of the chamber B so that the quantity of discharged oil from the chambers A and E is equal to the required quantity for the chamber B.

The tight clamping :

Following the high-speed mold closure by pressurizing the chamber C, after closing the mold (Fig. 2) with low speed and low pressure by reducing oil flow to the chamber C, the tight clamping is executed by supplying oil to the chamber B. At that time, the oil path 36 is closed by advanced high-pressure switching piston 38 while pressurizing the chamber F. As the chamber B is not at a negative pressure, the pressure rises quickly.

In this condition, the injection machine 27 is advanced and injects resin melt in the mold. After cooling and solidifying the resin, it is transferred to the next manufacturing step.

The mold opening :

After cooling and solidifying the resin, the high-pressure mold opening is executed. At that time, the pressure in the chamber B is relieved, and the chamber G is pressurized to retract the high-pressure switching piston 38. Then, at high pressure a small quantity of oil is supplied to the chamber D to open the mold with high pressure.

After the high-pressure opening, the high-speed opening is executed by increasing the oil quantity. Then oil quantity is reduced again to reduce opening speed shortly before the completion of the mold opening. Finally, the opening is completed by stopping the oil supply. In this case, the oil discharged from the chamber B is returned to the chambers A and E, and the oil in the chamber C is returned to the oil tank 45.

The spring-check valve 43 works to keep the tight clamping pressure at a constant level as a safety valve so it releases the compressed oil in the chambers A and E to the oil tank 45 in the tight clamping.

The check valve 44, during the change from the tight clamping operation to the mold opening operation and relieving the pressure in the chamber B, works to prevent negative pressure in the chambers A and E for a short period by sucking the oil from the oil tank whose quantity is equal to the oil quantity relieved from the chambers A and E. This leads to a smooth mold opening step.

In this invention, the effective pressure receiving area of the chamber B is basically designed to be equal to the sum of the effective pressure receiving area of the chambers A and E, but there actually occur measuring errors in the manufacturing process so it is difficult to satisfy this standard. There are cases in which the effective pressure receiving area of the chamber B is a little greater than the sum of the chamber A and E, or there are cases in which it is smaller. In the former cases, at the time of closing the mold, the oil quantity in the chambers A and E is reduced so extra oil is sucked from the oil tank 45 via the check valve 44, while at the time of opening of the mold, the surplus oil is returned to the oil tank 45 via the spring-check valve 43. In the latter cases, at the time of closing the mold, there is some surplus oil in the chambers A and E so it is returned to the oil tank 45 via the spring-check valve 43, while at the time of opening of the mold, the reduced quantity of oil is sucked from the oil tank 45 via the check valve 44.

A structure including the spring-check valve 43 and the check valve 44 is much easier to design because it is hardly necessary to consider the measuring errors.

In the above described embodiment, it is acceptable if the clamping cylinder 28 and the support cylinder 29 are not in one body, and the oil path 36 can be formed by a prescribed joint hose. Furthermore, the section of the high-speed switching cylinder 37 can be substituted by a prescribed external valve device (not shown). It is preferable to construct a differential oil circuit between the chambers C and D at the time of high speed advancing to equalize the advancing speed and the retracting speed.

Embodiment 2

The second embodiment of the invention will be described with reference to Figs. 4 to 6.

Chambers A and B are connected by a connecting-through-hole 47 provided in a large-diameter section of a clamping ram 30.

The chamber A and a chamber E are connected to each other by an oil path 48 provided in a wall which is provided between a clamping cylinder 28 and a support cylinder 29.

The rear end section of the clamping ram 30 is extended into the chamber B.

The extended section of the clamping ram 30 in the chamber B is composed of a large-diameter section 49 and a small-diameter section 50 extended from the large-diameter section 49. On the small-diameter section 50, there is fitted an open-close valve 51, which opens or closes the connecting-through-hole 47. The open-close valve 51 is movable in the axial direction of the clamping ram 30, and it is formed like a ring piston. The sleeve section 52 of the open-close valve 51 is guided along the outer face of the large-diameter section 49, and an end face of the sleeve section can close the connecting-through-hole 47. There is screwed a cap 53 on the end face of the

small-diameter section 50 to prevent slip-out and to restrict traveling length. A chamber H is formed by the inner face of the open-close valve 51 and the outer face of the small-diameter section 50. The chambers H and D are connected by a through-hole 54 bored in the clamping ram 30.

In this embodiment, the sum of the effective pressure receiving area of the chamber A of the clamping cylinder 28 (the area of the piston section of the clamping ram 30 minus the area of the rod section thereof) and the effective pressure receiving area of the chamber E of the support cylinder 29 (the area of the piston section of the support piston 34 minus the area of the rod section thereof) is also designed to be substantially equal to the effective pressure receiving area of the chamber B of the clamping cylinder 28 (the area of the piston section of the clamping ram 30 minus the area of the small-diameter section of the high-speed piston 31).

The action of the device will be described below.

The high-speed mold closure :

In the condition of opening the mold shown in Fig. 4, the high-speed mold closure is executed by supplying oil to the chamber C. At that time, the oil in the chamber D is returned to the oil tank 45.

The oil in the chambers A and E, which is compressed by advancing the movable board 20, travels to the chamber B via the connecting-through-hole 47. In this case, for the sum of the effective pressure receiving area of the chambers A and E to be substantially equal to the effective pressure receiving area of the chamber B, the oil quantity discharged from the chambers A and E will be equal to the oil quantity which is needed for the chamber B so that the chamber B will not be at a negative pressure.

For the chambers A and B to be connected to each other, the open-close valve 51 is moved in the position to open the connecting-through-hole 47 by oil resistance which occurs when the piston section of the clamping ram 30 travels.

The tight clamping :

Following the high-speed mold closure by pressurizing in the chamber C, the chamber B is pressurized after mold closure (Fig. 5) with low-speed and low-pressure by reducing oil flow to the chamber C. When the chamber B is pressurized, the chambers A and E are also pressurized via the connecting-through-hole 47 but the pressure therein is reduced to the spring's exerting pressure of the check valve 43 so that the pressure-difference occurs between the front and rear faces of the open-close valve 51. Then the valve 51 advances and the end face of the sleeve section 52 comes into contact with the piston section of the clamping ram 30 to close the connecting-through-hole 47 (Fig. 6).

The oil supplied to the chamber B works to the rear end face of the clamping ram 30 for the tight clamping. In this case, pressurizing in the chamber C is executed simultaneously, and the pressure in the chamber C also works for the tight clamping. In this status, maintaining the pressure, the injection machine 27 is advanced and injects resin melt into the molds for injection molding. The resin is thereafter cooled for solidification and transferred to the next mold opening step.

The mold opening :

After resin solidification, the pressure of the chamber B is relieved and the chamber D is pressurized for mold opening.

In this case, for the chamber H to be pressurized via the through-hole 54 when the chamber D is pressurized, the chambers A, B and E are connected by retracting the open-close valve 51, and the oil in the chamber B travels to the chamber A and E following retracting of the clamping ram 30 and the support piston 34. The oil in the chamber C is returned to the oil tank 45.

In this embodiment, the spring-check valve 43 also works to keep the tight clamping pressure constant as a safety valve so it releases the compressed oil in the chambers A and E to the oil tank 45 in the tight clamping procedure.

The check valve 44, while transferring from the tight clamping procedure to opening the mold and relieving the pressure in the chamber B, works to prevent negative pressure in the chambers A and E for a short time period by sucking the oil from the oil tank whose quantity is equal to the oil quantity relieved from the chambers A and E. This can be transferred to a smooth mold opening.

In this embodiment, the effective pressure receiving area of the chamber B is basically designed to be equal to the sum of the effective pressure receiving area of the chambers A and E, but there actually occur measuring errors in the manufacturing process so it is very difficult to be equal to the above value. Thus there are cases in which the effective pressure receiving area of the chamber B is greater than the sum of the chambers A and E, or smaller. In the former cases, at the time of closing the mold, the oil quantity in the chambers A and E is reduced so that extra oil is sucked from the oil tank 45 via the check valve 44, while at the time of opening the mold, the surplus oil is returned to the oil tank 45 via the spring-check valve 43. In the latter cases, at the time of closing the mold, there is some surplus oil in the chambers A and E so it is returned to the oil tank 45 via the spring-check valve 43, while at the time of opening the mold, the reduced amount of oil is sucked from the oil tank 45 via the check valve 44.

This structure including the spring-check valve 43 and the check valve 44 is easier to design because it is hardly necessary to consider the measuring errors.

Embodiment 3

The third embodiment is shown in Fig. 7.

In this embodiment, the inner diameter of the rear section of the clamping cylinder 28 is formed larger than the inner diameter of the front section thereof. The other components are essentially equal to the device of the second embodiment.

In the high-speed mold opening or closing, since the piston section of the clamping ram 30 will not contact the inner wall of the rear section of the clamping cylinder 28, slide-resistance is reduced so that faster mold opening or closing is possible. At that time, the oil movement between the chambers A, B and E is also executed smoothly via the space between the piston section and the inner wall with lower slide resistance. In the tight clamping procedure, the piston section is advanced to the position where the piston section fits into the inner wall and the tight clamping operation can be executed smoothly.

For the rear large-diameter section to have a clearance for tool operation, machining the clamping cylinder 28 can be executed easily and manufacturing costs can be reduced.

Embodiment 4

The fourth embodiment is shown in Fig. 8.

In this embodiment, a plurality of clamping cylinders 28 are provided side by side, and one support cylinder 29 works in conjunction with the clamping cylinders 28. The chamber E of the support cylinder 29 is connected to each chamber A of the clamping cylinders 28 by hose joints 56.

The total effective pressure receiving area of each chamber B of the clamping cylinder 28 is substantially equal to the sum of the total effective pressure receiving area of each chamber A of the clamping cylinders 28 and the effective pressure receiving area of the chamber E of the support cylinder 29. With this structure, the oil can circulate among the chambers A and B of the clamping cylinders 28 and the chamber E of the support cylinder 29 at the appropriate flowrate.

There are provided a plurality of clamping cylinders 28, so that great tight clamping force, e.g. thousands of tons, can be provided.

Even in a large machine whose movable board 20 is a large size, the movable board 20 can be pressed uniformly so flex of the movable board 20 will be reduced and uniform clamping force will be available. Precision of the mold clamping device thus can be increased.

In each embodiment described above, it is preferable to design the mold opening and closing in high speed operation to be approximately equal so that an external valve (not shown) is preferably provided to the chamber C, whose capacity is larger than the chamber D. The oil returned from the chamber D is also supplied to the chamber C via the external valve (not shown) so that the speed of mold opening will be approximately equal to the speed of closing the mold.

Embodiment 5

The embodiment shown in Figs. 9 and 10 is constructed to make the speeds of mold opening and closing approximately equal without external valves.

In this embodiment, an oil path 33, which is provided in the high-speed piston 31 to connect the chamber D, is also connected to the chamber C via a connecting oil path. The chambers C and D are connected to each other via an opening section 57 in the chamber C and the oil path 33. The part of the oil path 33 corresponding to the opening section 57 is formed as a large-diameter oil path 58. In this large-diameter oil path 58, there is slidably fitted a valve element 59. A male screw 60 having an oil path is screwed into the female screw section engraved in one end section of the oil path 33 to form a part of the large-diameter oil path 58.

In a high speed mold closure procedure, the chambers C and D are connected to each other by retracting the valve element 59 shown in Fig. 9 when the chamber C is pressurized. The chamber D is also pressurized but the pressure in the chamber C is larger than that in the chamber D so that the oil in the chamber D circulates to the chamber C and the speed of mold closure is accelerated.

In the mold opening procedure, the mold is opened by pressurization of the chamber D as shown in Fig. 10, the valve element 59 is advanced to shut a connection to the chamber C and the oil in the chamber C is returned to an oil tank. Therefore, mold opening and closing can be executed at approximately the same speed.

In this embodiment, external valves and external pipings are needless and the structure of the device can be simplified and manufacturing costs can be reduced. The oil circulation length between the chambers C and D can be shortened so that flow resistance can be reduced in addition to a reduction in energy consumption.

Furthermore, when this modification is applied to the embodiments 2 to 4, in the mold closure, the chamber H is pressurized via the chamber D so that the open-close valve 51 is opened. There is an advantage that connection between the chambers A and B is correctly executed.

Embodiment 6

The sixth embodiment is shown in Fig. 11.

In this embodiment, the inner space of the clamping ram 30 is divided into a front chamber J opening to the atmosphere and a rear chamber D by the large-diameter piston section provided at the front end of the high-speed piston 31. The chamber J is opened to the atmosphere. The chambers D and H are connected each other via through-hole 54.

A piston rod 62, which projects from the inner bottom of the chamber J of the clamping ram 30, is slidably fitted in the high-speed piston 31 from the side of the front end thereof, so there is formed a third chamber C in the high-speed piston 31. The chambers C and D are connected to a hydraulic device (not shown) provided outside of a cylinder block 22 via oil paths 32 and 33. There are provided switching valves (not shown) outside of the cylinder block 22 in the oil paths 32 and 33 so that return oil from the chamber C can be supplied to the chamber D via the oil path 33.

In the high-speed mold closure operation, the chamber C is pressurized ; in the tight clamping operation, the chamber B is pressurized ; and in the high-pressure mold opening, the chamber D is pressurized. The operation of the open-close valve 51 is the same as described with respect to the other embodiments.

In this embodiment, the effective pressure receiving area of the chamber C can be designed to be small and high-speed and low-pressure mold closure can be executed. The high-pressure mold opening by pressurizing the chamber D can be executed in the same manner as in the above embodiments.

Acceleration of the mold opening can be executed by combining the return oil from the chamber C with the oil path 33 via the oil path 32 and the switching valve (not shown), so that mold opening and closing can be executed at the same speed.

The mold clamping device can be preferably applied to injection molding machines, die casting machines and the like, as a clamping device.

Claims

1. A mold clamping device comprising :
a clamping cylinder (28) slidably fitted with a clamping ram (30) whose front end is intended to be connected to a movable element (20) of a mold assembly (20, 21, 23-25) ; a high-speed piston (31) being slidably fitted in said cavity of the clamping ram (30) from the rear thereof ;
a support cylinder (29) which is provided in parallel to said clamping cylinder (28), and a support piston (34) fitted therein, said piston (34) dividing the cavity of the support cylinder (29) into front (E) and rear chambers, and having a rod (46) whose front end is intended to be connected to said movable element (20) ; there being an oil path (36) connecting said front chamber (A) and rear chamber (B) of said clamping cylinder (28) and said front chamber (E) of said support cylinder (29) ;
a means (37, 38) being provided for opening and closing said oil path (36) to said rear chamber (B) of said clamping cylinder (28) ;
wherein the sum of the effective pressure receiving area of said front chamber (A) of said clamping cylinder (28) and said front chamber (E) of said support cylinder (29) is substantially equal to the effective pressure receiving area of said rear chamber (B) of said clamping cylinder (28).

2. A mold clamping device according to claim 1 wherein, said clamping cylinder (28) and said support cylinder (29) are formed in one body as a cylinder block, and the oil path (36) connecting said front (A) and rear (B) chambers of said clamping cylinder (28) and said front chamber (E) of said support cylinder (29) is bored in the wall of said cylinder block.

3. A mold clamping device according to claim 1 wherein said oil path is provided by a connecting through-hole (47) in the piston section of said clamping ram connecting the front chamber (A) and a rear chamber (B) of said clamping cylinder (28), and an oil path (48) connecting the front chamber (E) of said support cylinder (29) to said front chamber (A) of said clamping cylinder ; and said opening and closing means comprises a valve member (51) displaceably mounted on the rear of said clamping ram (30) ; and wherein a further chamber (H) is defined between the valve member (51) and the ram (30), and a through-hole (54) in said clamping ram connects said chamber (H) to said second chamber (D) of said clamping ram.

4. A mold clamping device according to claim 3 wherein said rear of the ram (30) has a portion of relatively large diameter and a rearward portion of relatively small diameter ; said valve member (51) comprising a ring piston having portions slidably engaging said large and small diameter portions ; said ring piston (51) being slidable to open and close the through-hole (47) which connects the front (A) and rear (B) chambers of the clamping cylinder (28).

5. A mold clamping device according to any preceding claim wherein, said means for opening and closing said oil path (36) is a switching valve.

6. A mold clamping device according to any preceding claim wherein said front chamber (A) of said clamping cylinder (28) or said front chamber (E) of said support cylinder (29) is connected to an oil tank (45) via a spring-check valve (43) which releases oil to the oil tank (45) and via a check valve, which is provided in parallel to said spring-check valve, for sucking oil from the oil tank (45).

7. A mold clamping device according to any preceding claim wherein the piston section of said clamping ram (30) is provided at the rear end of said

clamping ram (30).

8. A mold clamping device according to any preceding claim wherein the high-speed piston 31 is fixed at its rear end to an inner rear wall of said clamping cylinder (28).

9. A mold clamping device according to any preceding claim wherein the cavity of said clamping ram (30) is divided into a front chamber (J) opening to the atmosphere and a rear chamber (D) by a large-diameter piston section povided at the front end of said high-speed piston (34) and a piston rod (62) extending from an inner wall face of said front chamber of said clamping ram is slidably fitted in said high-speed piston (31) to form a third chamber (C) in said high-speed piston.

10. A mold clamping device according to any of claims 1 to 8 wherein, the inner space of said clamping ram (30) is divided into a first chamber (C) and a second chamber (D) by a large-diameter piston section provided at the front end of said high-speed piston (31) ; said first chamber (C) being connected to an oil pressure source via an oil path (32) bored through said high-speed piston, and said second chamber (D) being connected to said oil pressure source via an oil path (33) having one end opened at the rear end of said high-speed piston and the other end on the outer face of said high-speed piston in said second chamber of said clamping ram.

11. A mold clamping device according to claim 10 wherein, said oil path connected to said second chamber (D) of said clamping ram is also connected to said first chamber (C) via a connecting path (57,58,60), and a valve element (59), which is slidably fitted in a large-diameter section (58) of said connecting path, serves for shutting said oil path to said second chamber (D) of said clamping ram under the influence of oil pressure in said first chamber (C) when oil is introduced into said first chamber (C) for mold closure ; and for opening said oil path to said second chamber (D) and shutting said connecting path under the influence of oil pressure in said second chamber (D) when oil is introduced into said second chamber (D) for opening the mold.

12. A mold clamping device according to any preceding claim wherein, the internal diameter of the rear section of said clamping cylinder is larger than the internal diameter of the front section thereof, and the inner diameter of the front section is formed to fit the piston section of said clamping ram slidably.

13. A mold clamping device according to any preceding claim wherein, a plurality of clamping cylinders (28) are provided, and each front chamber (A) of each clamping cylinder is connected to said front chamber (E) of said support cylinder (29), and the total effective pressure receiving area of the rear chambers (B) of said clamping cylinders is substantially equal to the sum of the total effective pressure receiving area of the front chambers (A) of said clamping cylinders and the effective pressure receiving area of said front chamber (E) of said support cylinder.

Ansprüche

1. Eine Formschließvorrichtung, welche umfaßt : eine Schließzylinder (28) mit einem verschiebbar aufgenommenen Schließstempel (30), dessen vorderes Ende dafür vorgesehen ist, mit einem beweglichen Element (20) einer Formwerkzeuganordnung (20, 21, 23-25) verbunden zu sein ; einen Hochgeschwindigkeitskolben (31), der in diesen Hohlraum des Schließstempels (30) von dessen Rückseite her verschiebbar aufgenommen ist ; einem Hilfszylinder (29), welcher parallel zum Schließzylinder (298) vorgesehen ist, und einen darin aufgenommenen Hilfskolben (34), welcher Kolben (34) den Hohlraum des Hilfszylinders (29) in vordere (E) und hintere Kammern teilt und eine Stange (46) besitzt, deren vorderes Ende dafür vorgesehen ist, mit dem beweglichen Element (29) verbunden zu sein ; wobei ein Ölpfad (36) vorhanden ist, der die vordere Kammer (A) und die hintere Kammer (B) des Schließzylinders und die vordere Kammer (E) des Hilfszylinders (29) verbindet ; ein Mittel (37, 38) das zum Öffnen und Schließen des Ölpfades (36) zur hinteren Kammer (B) des Schließzylinders (28) vorgesehen ist ; wobei die Summe der wirksamen Druckaufnahmefläche der vorderen kammer (A) des Schließzylinders (28) und der vorderen Kammer (E) des Hilfszylinders (29) im wesentlichen gleich der wirksamen Druckaufnahmefläche der hinteren Kammer (B) des Schließzylinders (28) ist.

2. Eine Formschließvorrichtung gemäß Anspruch 1, wobei der Schließzylinder (28) und der Hilfszylinder (29) in einem Körper als ein Zylinderblock ausgebildet sind und der die vordere (A) und hintere (B) Kammer des Schließzylinders (28) und die vordere Kammer (E) des Hilfszylinders (29) verbindende Ölpfad in die Wand dieses Zylinderblockes gebohrt ist.

3. Eine Formschließvorrichtung gemäß Anspruch 1, wobei dieser Ölpfad von einem Verbindungs-Durchgangsloch (47) im Kolbenabschnitt des Schließstempels, welches die vordere Kammer (A) und eine hintere Kammer (B) des Schließzylinders (28) verbindet, und einem Ölpfad (48), welcher die vordere Kammer (E) des Hilfszylinders (29) mit der vorderen Kammer (A) des Schließzylinders verbindet vorgesehen ist ; und wobei dieses Mittel zum Öffnen und Schließen ein an der Rückseite des Schließstempels (30) verlagerbar montiertes Ventilelement (51) aufweist ; und wobei eine weitere Kammer (H) zwischen dem Ventilelement (51) und dem Stempel (30) definiet ist und ein Durchgangsloch (54) in dem Schließstempel diese Kammer (H) mit der zweiten Kammer (D) des Schließstempels verbindet.

4. Eine Formschließvorrichtung gemäß Anspruch 3, wobei diese Rückseite des Stempels (30) einen

Aschnitt mit relativ großem Durchmesser und einen hinteren Abschnitt mit relativ kleinem Durchmesser aufweist ; das Ventilelement (51) einen Ringkolben mit Abschnitten aufweist, die mit den den großen und kleinen Durchmesser aufweisenden Abschnitten verschiebbar im Eingriff stehen ; der Ringkolben (51) zum Öffnen und Schließen des die vordere (A) und hintere (B) Kammer des Schließzylinders (28) verbindenden Durchgangsloches (47) verschiebbar ist.

5. Eine Formschließvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, wobei das Mittel zum Öffnen und Schließen des Ölpfades (36) ein Schalventil ist.

6. Eine Formschließvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, wobei die vordere kammer (A) des Schließzylinders (28) oder die vordere Kammer (E) des Hilfszylinders (29) mit einem Öltank (25) über ein Rückschlagventil (43) mit Feder, welches Öl zum Öltank (45) ablaufen läßt, und über ein parallel zu dem Rückschlagventil mit Feder angeordnetes Rückschlagventil zum Ansaugen von Öl aus dem Öltank (45) verbunden ist.

7. Eine Formschließvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, wobei der kolbenabschnitt des Schließstempels (30)am hinteren Ende des Schließstempels (30) vorgesehen ist.

8. Eine Formschließvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, wobei der Hochgeschwindigkeitskolben (31) an seinem hinteren Ende an der inneren Rückwand des Schließzylinders befestigt ist.

9. Eine Formschließvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, wobei der Hohlraum des Schließstempels (30) durch einen, am vorderen Ende des Hochgeschwindigkeitskolbens (34) vorgesehenen Kolbenabschnitt mit großem Durchmesser in eine zur Atmosphäre offene vordere Kammer (J) und eine hintere Kammer (D) geteilt ist, und eine sich von einer Innenwandfläche der vorderen Kammer des Schließstempels erstreckende kolbenstange (62) in dem Hochgeschwindigkeitskolben (31) verschiebbar aufgenommen ist, um in dem Hochgeschwindigkeitskolben eine dritte Kammer (C) zu bilden.

10. Eine Formschließvorrichtung gemäß irgendeinem der Ansprüch 1 bis 8, wobei der Innenraum des Schließstempels (30) durch einen am vorderen Ende des Hochgeschwindigkeitskolbens (31) vorgesehenen Kolenabschnitt mit größerem Durchmesser in eine erste Kammer (C) und eine zweite Kammer (D) geteilt ist ; wobei die erste Kammer (C) über durch den Hochgeschwindigkeitskolben gebohrten Ölpfad (32) mit einer Öldruckquelle verbunden ist und die zweite Kammer (D) mit dieser Öldruckquelle über einen Ölpfad (33) verbunden ist, von dem ein Ende am hinteren Ende des hochgeschwindikeitskolbens und das andere Ende an der Außenseite des Hochgeschwindigkeitskolbens in der zweiten Kammer des Schließstempels mündet.

11. Eine Formschließvorrichtung gemäß Anspruch 10, wobei der mit der zweiten Kammer (D) des Schließstempels verbundene Ölpfad über einen Verbindungspfad (57, 58, 60) auch mit der ersten Kammer (C) verbunden ist und ein in einem mit großem Durchmesser versehenen Abschnitt (58) des verbindungspfades verschiebbar aufgenommenes Ventilelement (59) dazu dient unter dem Einfluß des Öldrucks din der ersten Kammer (C), wenn zu Schließen des Formwerkzeuges Öl in die erste Kammer (C) eingeführt wird, den Ölpfad zur zweiten Kammer (D) des Schließstempels zu schließen und unter dem Einfluß des Öldrucks in der zweiten Kammer (D), wenn zum Öffnen des Formwerkzeuges Öl in die zweite Kammer (D) eingeführt wird, den Ölpfad zur zweiten Kammer (D) zu öffnen und den Verbindungspfad zu schließen.

12. Eine Formschließvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, wobei der Innendurchmesser des hinteren Abschnittes des Schließzylinders größer ist als der Innendurchmesser von dessen vorderem Abschnitt und der Innendurchmesser des vorderen Abschnittes zum verschiebbaren Aufnehmen des Kolbenabschnittes des Schließstempels ausgebildet ist.

13. Eine Formschließvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, wobei eine Vielzahl an Schießzylindern (28) vorgesehen ist und jede vordere Kammer (A) jedes Schließzylinders mit der vorderen kammer (E) des Hilfszylinders (29) verbunden ist und die gesamte wirksame Druckaufnahmefläche der hinteren Kammer (B) der Schließzylinder im wesentlichen gleich der Summe der gesamten wirksamen Druckaufnahmefläche der vorderen Kammer (A) der Schließzylinder und der wirksamen Durckaufnahmefläche der vorderen Kammer (E) des Hilfszylinders ist.

Revendications

1. Dispositif de serrage de moule, comportant : un cylindre de serrage (28), muni de façon coulissante d'un vérin de serrage (30) sont l'extrémité antérieure est destinée à être reliées à un organe mobile (20) d'un agencement de moule (20, 21, 23 à 25), un piston rapide (31) étant logé de manière coulissante dans ladite cavité du vérin de serrage (30), depuis l'arrière de celle-ci; un cylindre de support (29) disposé parallèlement audit cylindre de serrage (28), et un piston de support (34) logé dans celui-ci, ledit piston (34) divisant la cavité du cylindre de support (29) en chambres antérieure (E) et postérieure, et ayant une tige (46) dont l'extrémité antérieure est destinée à être reliée audit organe mobile (20), un passage (36) d'huile reliant lesdites chambre

antérieure (A) et chambre postérieure (B) dudit cylindre de serrage (28) et ladite chambre antérieure (E) dudit cylindre de support (29) ;
un moyen (37, 38) prévu pour ouvrir et fermer ledit passage (36) d'huile vers ladite chambre postérieure (B) dudit cylindre de serrage (28) ;
dans lequel la somme de la section effective de réception de pression de ladite chambre antérieure (A) dudit cylindre de serrage (28) et de ladite chambre antérieure (E) dudit cylindre de support (29) est sensiblement égale à la section effective de réception de pression de ladite chambre postérieure (B) dudit cylindre de serrage (28).

2. Dispositif de serrage de moule selon la revendication 1, dans lequel ledit cylindre de serrage (28) et ledit cylindre de support (29) constituent un ensemble solidaire sous la forme d'un bloc-cylindres, et le parcours (36) d'huile reliant lesdites chambres antérieure (A) et postérieure (B) dudit cylindre de serrage (28) et ladite chambre antérieure (E) dudit cylindre de support (29) est percé dans la paroi dudit bloc-cylindres.

3. Dispositif de serrage de moule selon la revendication 1, dans lequel ledit passage d'huile est constitué par un trou traversant de liaison (47) dans la partie formant piston dudit vérin de serrage, reliant la chambre antérieure (A) et la chambre postérieure (B) dudit cylindre de serrage (28), et un passage (48) d'huile reliant la chambre antérieure (E) dudit cylindre de support (29) à ladite chambre antérieure (A) dudit cylindre de serrage ; et ledit moyen d'ouverture et de fermeture comporte un élément formant soupape (51) monté de manière déplaçable à l'arrière dudit vérin de serrage (30) ; et dans lequel une autre chambre (H) est définie entre l'élément formant soupape (51) et le vérin (30), et un trou traversant (54) dans ledit vérin de serrage relie ladite chambre (H) à ladite seconde chambre (D) dudit vérin de serrage.

4. Dispositif de serrage de moule selon la revendication 3, dans lequel ledit arrière du vérin (30) a une partie d'un diamètre relativement grand et une partie postérieure d'un diamètre relativement petit ; ledit organe formant soupape (51) comprenant un piston à segments dont des parties viennent de manière coulissante contre lesdites parties de diamètres grand et petit ; ledit piston (51) à segments pouvant coulisser pour ouvrir et fermer le trou traversant (47) qui relie les chambres antérieure (A) et postérieure (B) du cylindre de serrage (28).

5. Dispositif de serrage de moule selon l'une quelconque des revendications précédentes, dans lequel ledit moyen pour ouvrir et fermer ledit passage (36) d'huile est une soupape de commutation.

6. Dispositif de serrage de moule selon l'une quelconque des revendications précédentes, dans lequel ladite chambre antérieure (A) dudit cylindre de serrage (28) ou ladite chambre antérieure (E) dudit cylindre de support (29) est reliée à un réservoir (45) d'huile par l'intermédiaire d'un clapet anti-retour (43) à ressort qui refoule de l'huile jusque dans le réservoir (45) d'huile, et par l'intermédiaire d'un clapet anti-retour disposé parallèlement audit clapet anti-retour à ressort, pour aspirer de l'huile à partir du réservoir (45) d'huile).

7. Dispositif de serrage de moule selon l'une quelconque des revendications précédentes, dans lequel la partie formant piston dudit vérin de serrage (30) est disposée à l'extrémité arrière dudit vérin de serrage (30).

8. Dispositif de serrage de moule selon l'une quelconque des revendications précédentes, dans lequel le piston rapide (31) est fixé, au niveau de son extrémité arrière, à une paroi postérieure interne dudit cylindre de serrage (28).

9. Dispositif de serrage de moule selon l'une quelconque des revendications précédentes, dans lequel la cavité dudit vérin de serrage (30) est divisée en une chambre antérieure (J) débouchant dans l'atmosphère et une chambre postérieure (D) par une partie formant piston d'un grand diamètre présente à l'extrémité antérieure dudit piston rapide (34), et une tige (62) de piston s'étendant depuis une face formant paroi interne de ladite chambre antérieure dudit vérin de serrage est logée de manière coulissante dans ledit piston rapide (31) pour former une troisième chambre (C) dans ledit piston rapide.

10. Dispositif de serrage de moule selon l'une quelconques des revendications 1 à 8, dans lequel l'espace interne dudit vérin de serrage (30) est divisé en une première chambre (C) et une seconde chambre (D) par une partie formant piston d'un grand diamètre présente à l'extrémité antérieure dudit piston rapide (31) ; ladite première chambre (C) étant reliée à une source de pression d'huile via un passage (32) d'huile percé à travers ledit piston rapide, et ladite seconde chambre (D) étant reliée à ladite source de pression d'huile via un passage (33) d'huile dont une première extrémité débouche à l'extrémité postérieure dudit piston rapide et l'autre extrémité sur la face extérieure dudit piston rapide dans ladite seconde chambre dudit vérin de serrage.

11. Dispositif de serrage de moule selon la revendication 10, dans lequel ledit passage d'huile relié à ladite seconde chambre (D) dudit vérin de serrage est également reliée à ladite première chambre (C) via un passage de liaison (57, 58, 60), et un élément formant soupape (59), logé de manière coulissante dans une partie (58) à grand diamètre dudit passage de liaison, sert à fermer ledit passage d'huile vers ladite seconde chambre (D) dudit vérin de serrage sous l'action de la pression d'huile existant dans ladite première chambre (C) quand de l'huile est introduite dans ladite première chambre (C) pour la fermeture du moule, et à fermer ledit passage de liaison sous l'action de la pression d'huile existant dans ladite seconde chambre (D) quand de l'huile est introduite dans ladite

seconde chambre (D) pour ouvrir le moule.

12. Dispositif de serrage de moule selon l'une quelconque des revendications précédentes, dans lequel le diamètre intérieur de la partie postérieure dudit cylindre de serrage est plus grand que le diamètre intérieur de la partie antérieure de celui-ci, et le diamètre intérieur de la partie antérieure est conçu pour être reçu de manière coulissante dans la partie formant piston dudit vérin de serrage.

13. Dispositif de serrage de moule selon l'une quelconque des revendications précédentes, dans lequel sont présents une pluralité de cylindres de serrage (28), et chaque chambre antérieure (A) de chaque cylindre de serrage est reliée à ladite chambre antérieure (E) dudit cylindre de support (29), et la section effective totale de réception de pression des chambres postérieures (B) desdits cylindres de serrage est sensiblement égale à la somme de la section effective totale de réception de pression des chambres antérieures (A) desdits cylindres de serrage et de la section effective de réception de pression de ladite chambre antérieure (E) dudit cylindre de support.

FIG.1

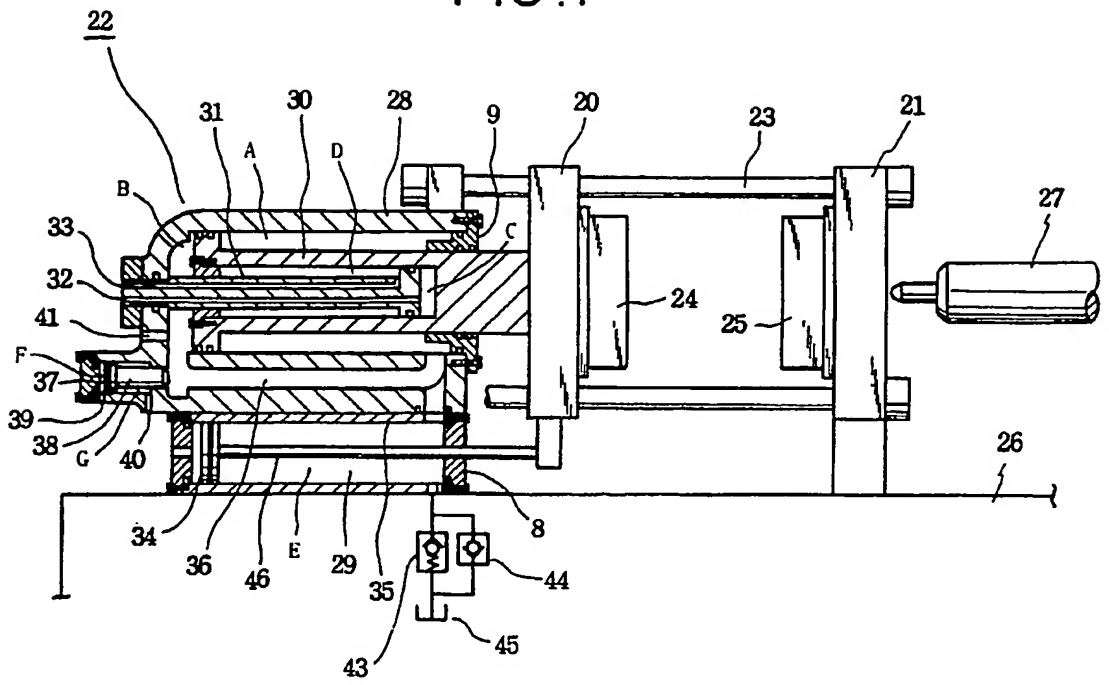
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FIG.2

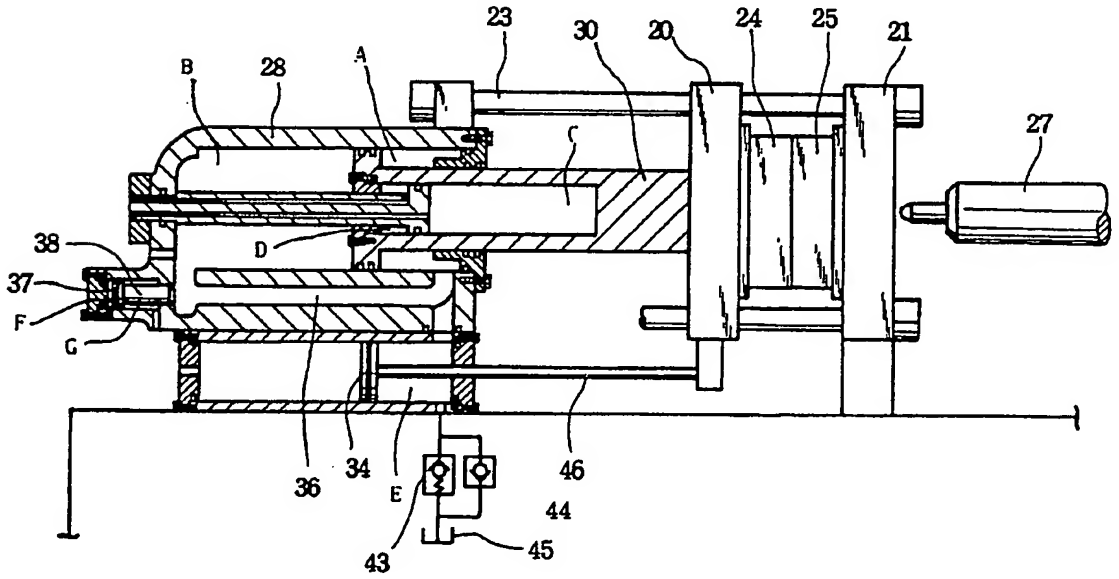
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FIG.3

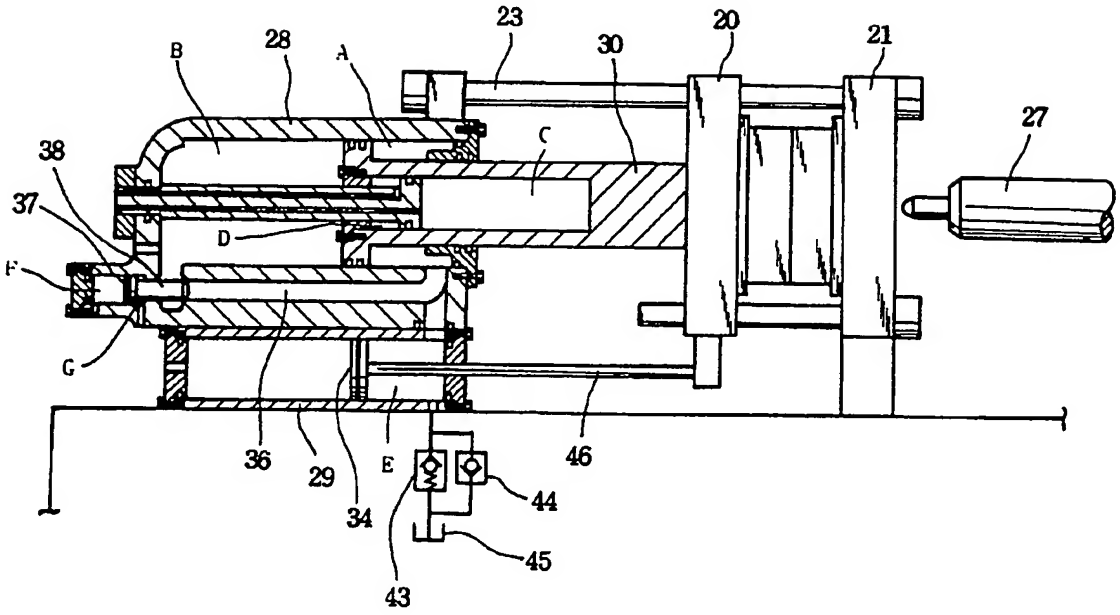
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FIG.4

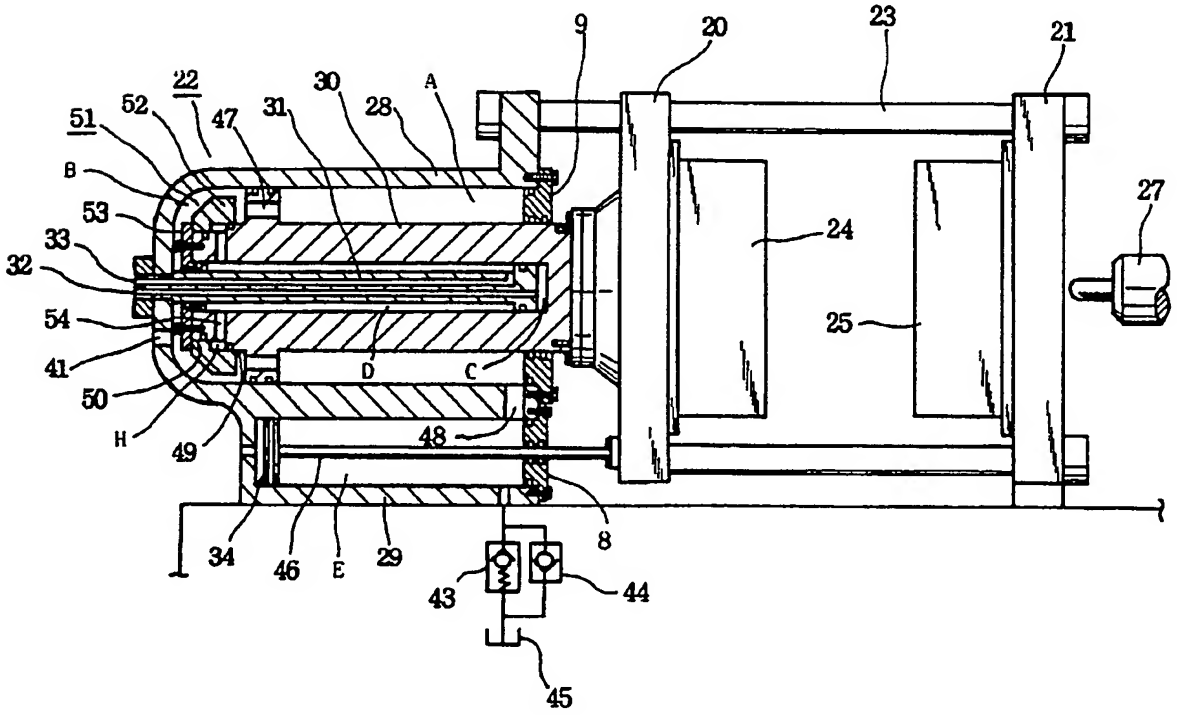
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FIG.5

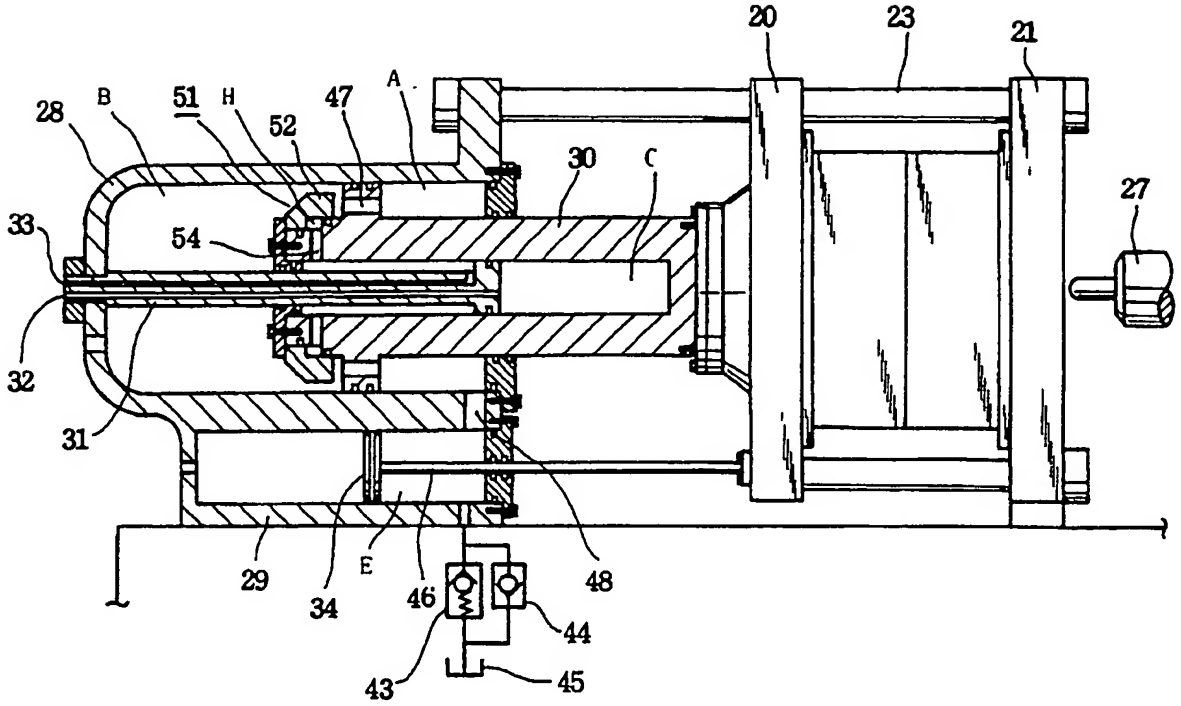
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FIG.6

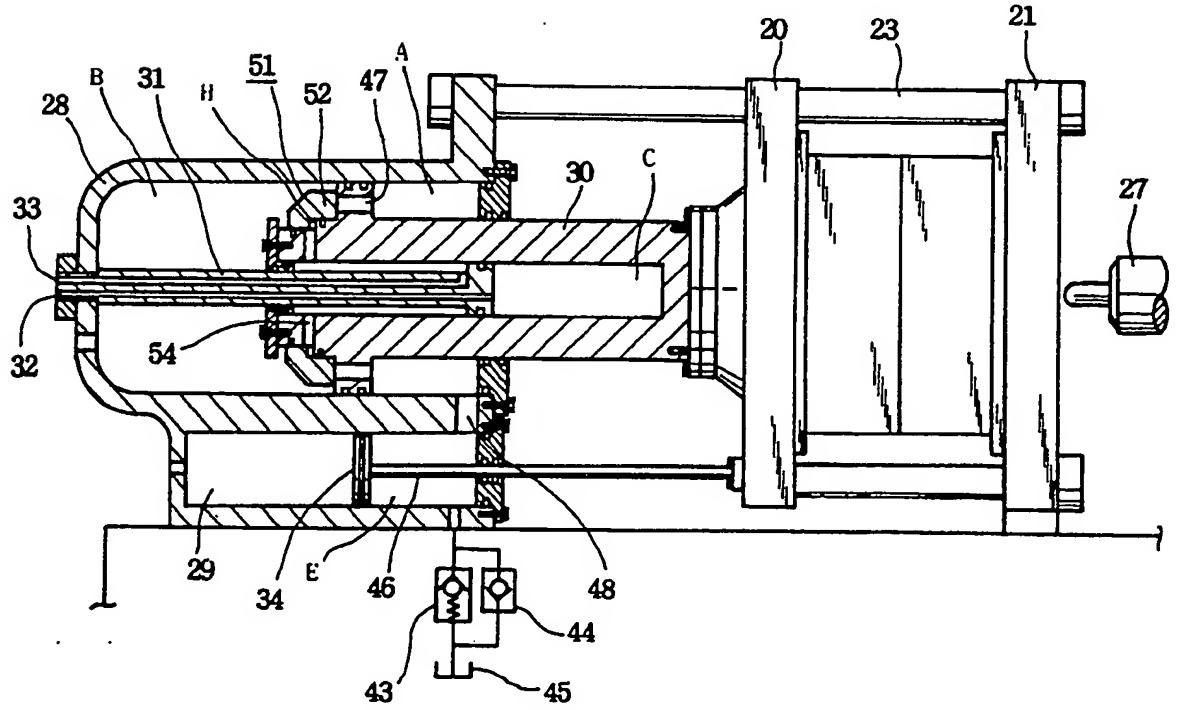
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FIG.7

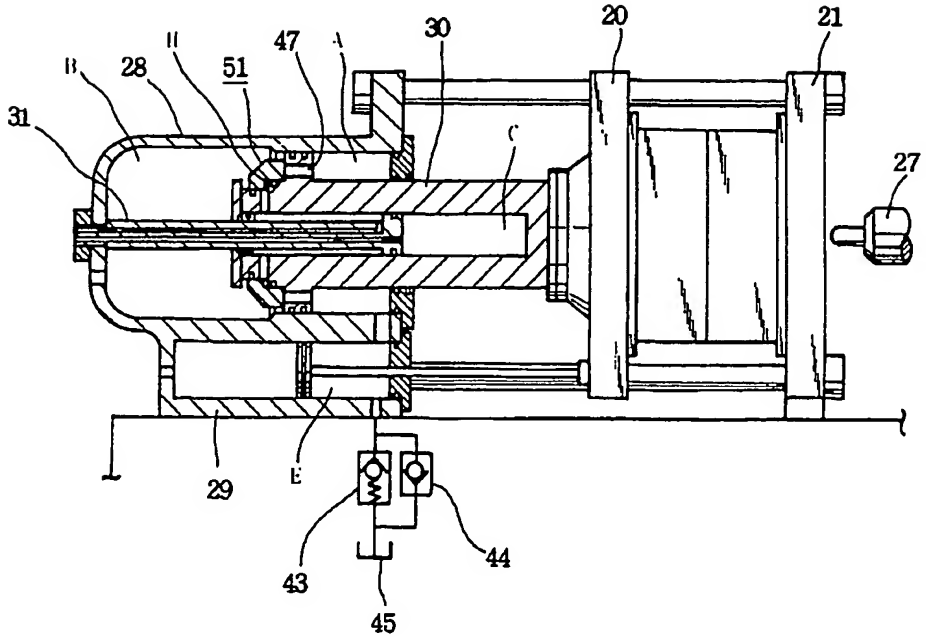
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FIG.8

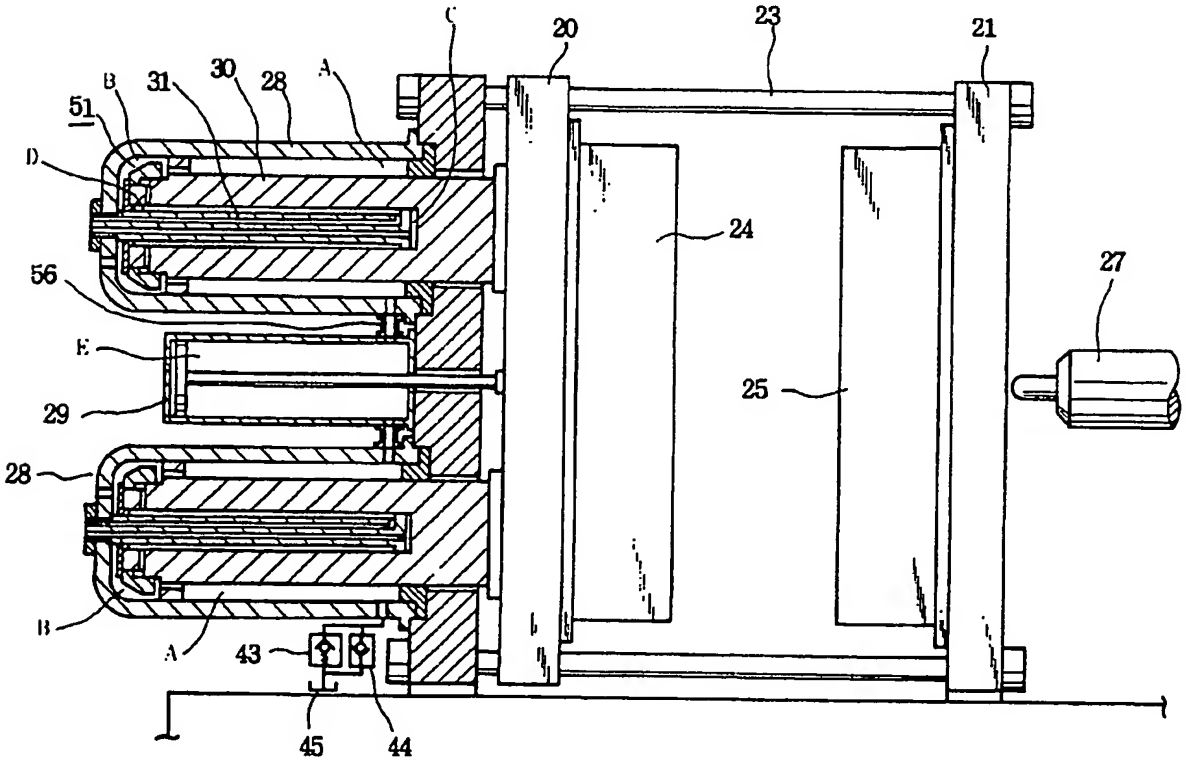
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FIG.9

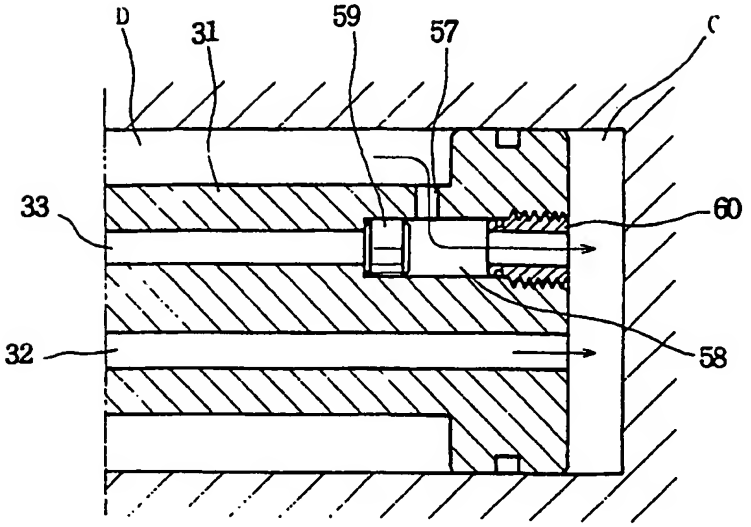


FIG.10

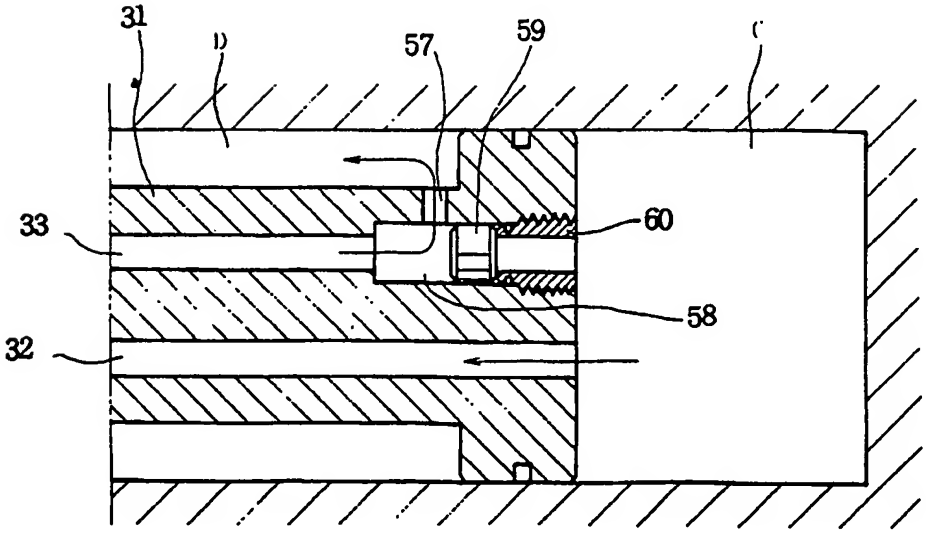
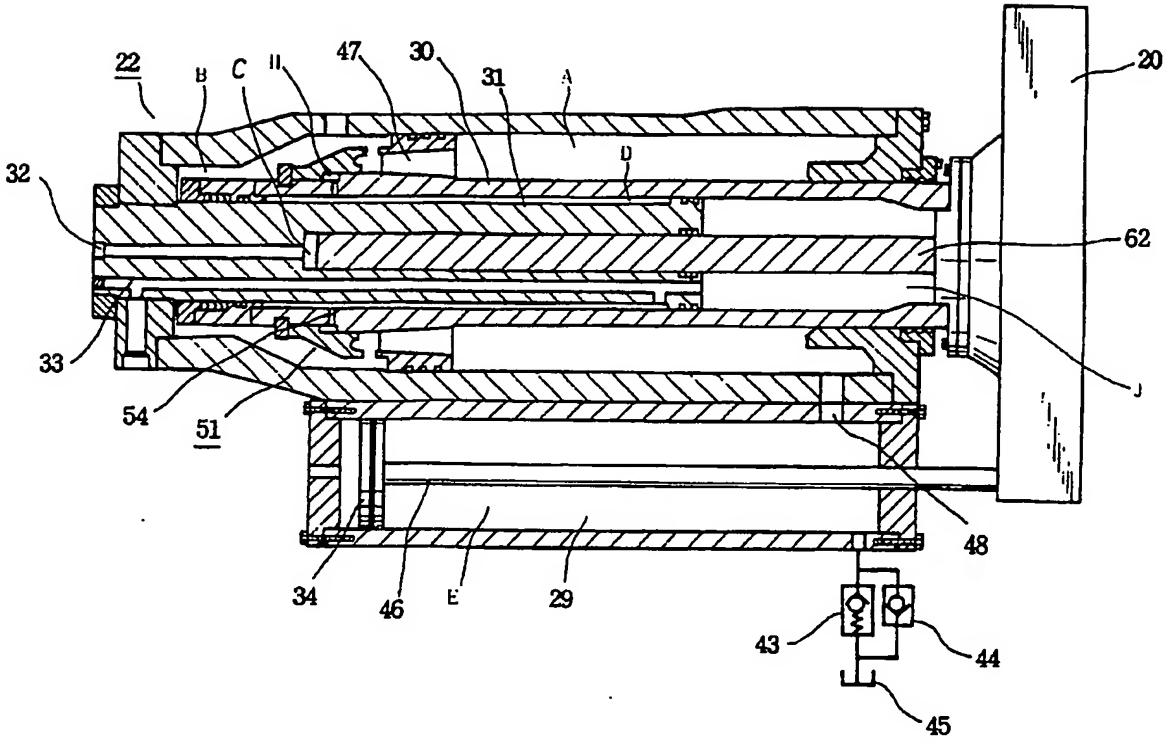


FIG.11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II
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A
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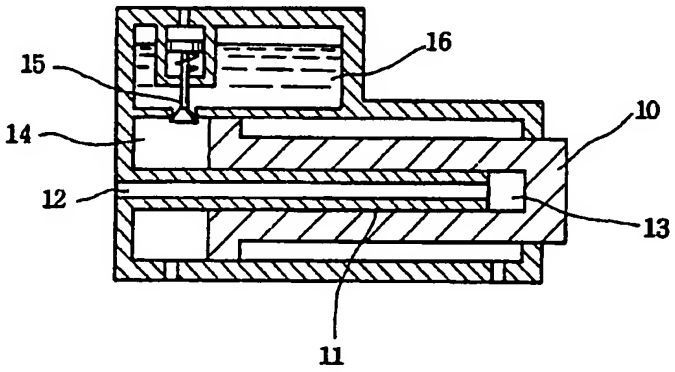
FIG.12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